

Optical Part of the CMB for AHCAL-CALICE

Jaroslav Zalesak
Institute of Physics, Prague

Present system: one tile – one optical fibre
complicated system

Idea: use one fibre for more tiles, ideally one row of tiles – one fibre

How to do it?

a) Side-emitting fibres

- Problems: search thin (~1mm) fibres, unknown parameters, cost
→ *FiberTech* (SLS600 series)

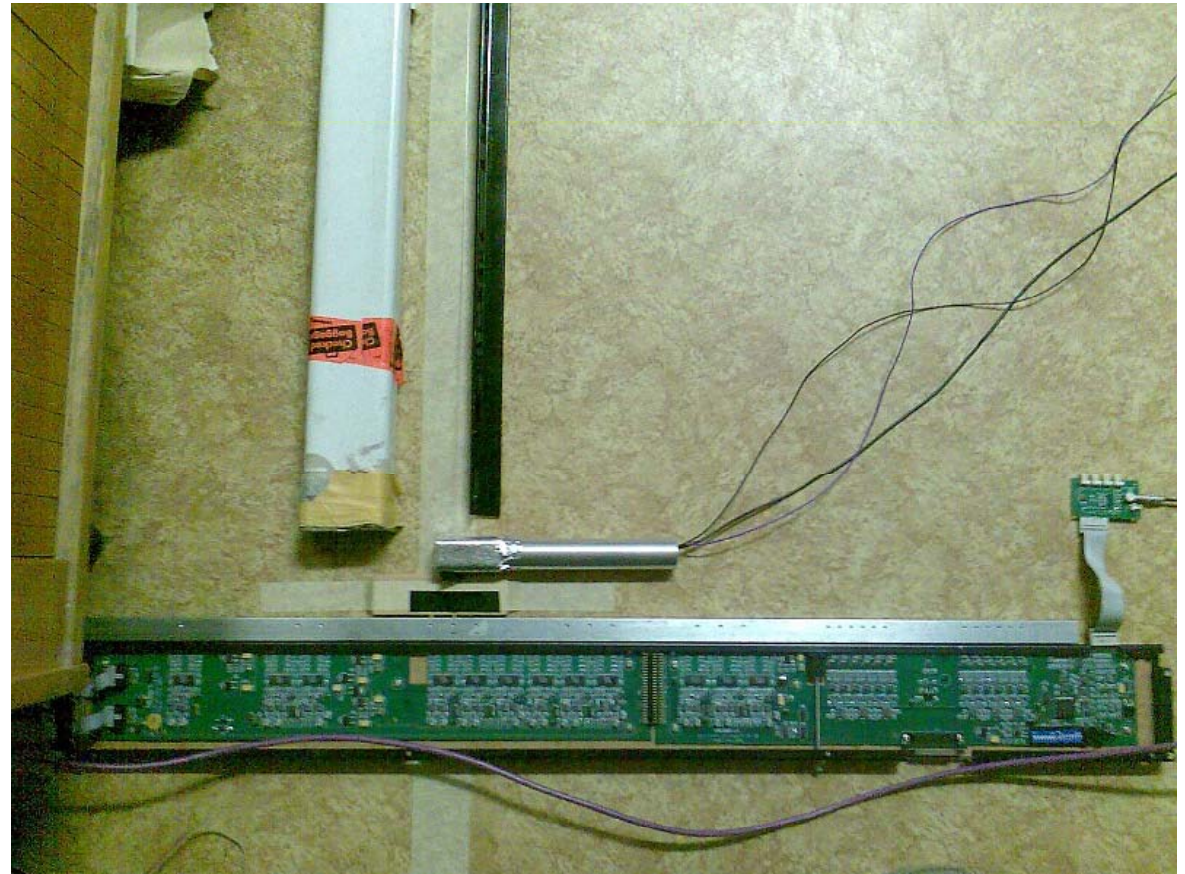
b) 'Notched' fibres

- Making notches on fibres (manually) → *Safibra company* (PoF)
- Non-uniformity of emitting light → *measurement*

c) Focusing enough LED light into fibre

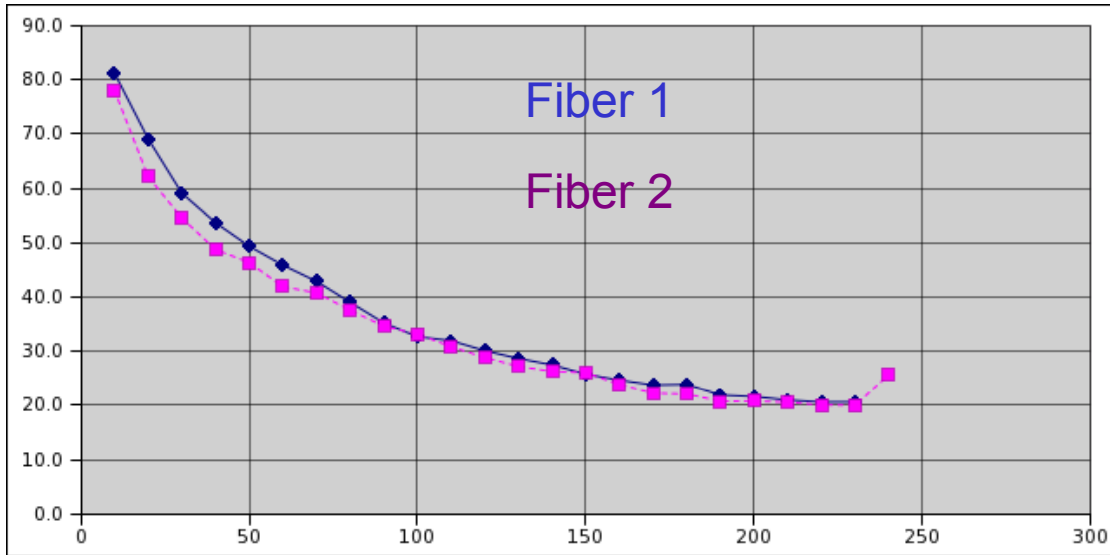
→ *in progress*

Measurement setup I



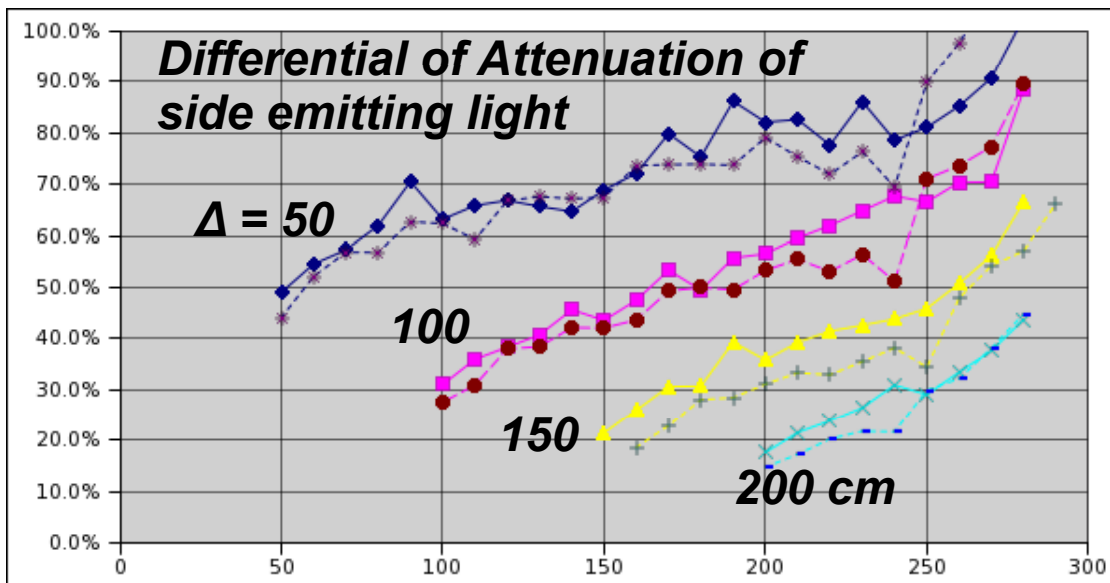
3-meter-long setup to have straight line fiber position (avoid twisting)
CMB + UV LED pulsing light - PMT R647 Hamamatsu – Scope Readout

Side – emitting fiber (FiberTech)



Dependence of signal amplitude [mV] on position of PMT

Side emitting light intensity decreases along fiber (position in cm from the UV LED source)



Running differential of attenuation of side-emitting light at length of 50, 100, 150 and 200 cm averaged of 75%, 55%, 40% and 30%

(Exponential decrease expectation softly violated)

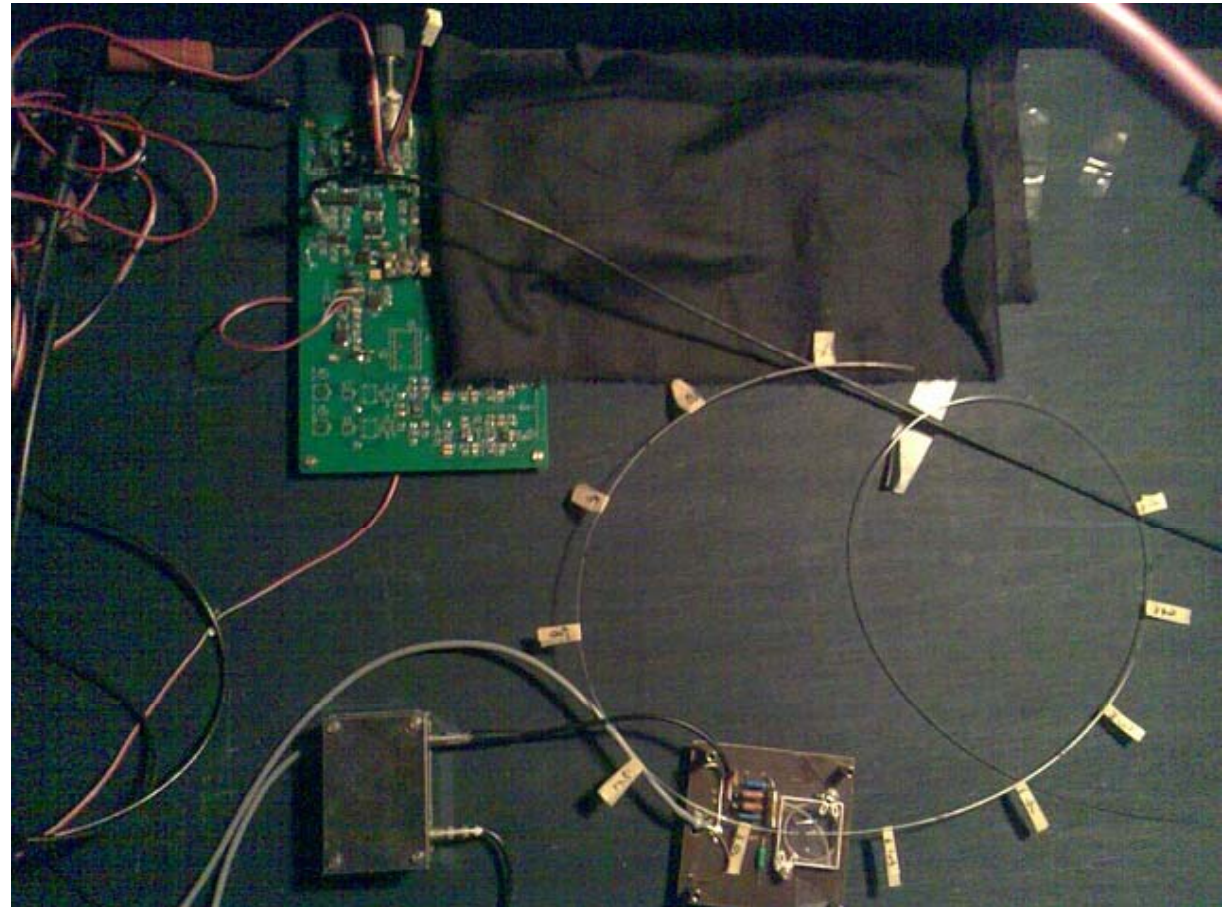
Conclusion I

- **All found and measured side-emitting fibers show same results within systematic uncertainties**
- **Side-emitting light intensity decreases along the fiber going from UV LED light source to the free end of fiber down to 20-30% at position > 2.5 m from source**
- **Attenuation of side-emitting light at length of 1m and 2m are approx. at level of 55% and 25%, resp.**
- **not fully sufficient fibers for calibration system due to non-uniformity in response and absolute int.**

Measurement setup II - Notched fibers

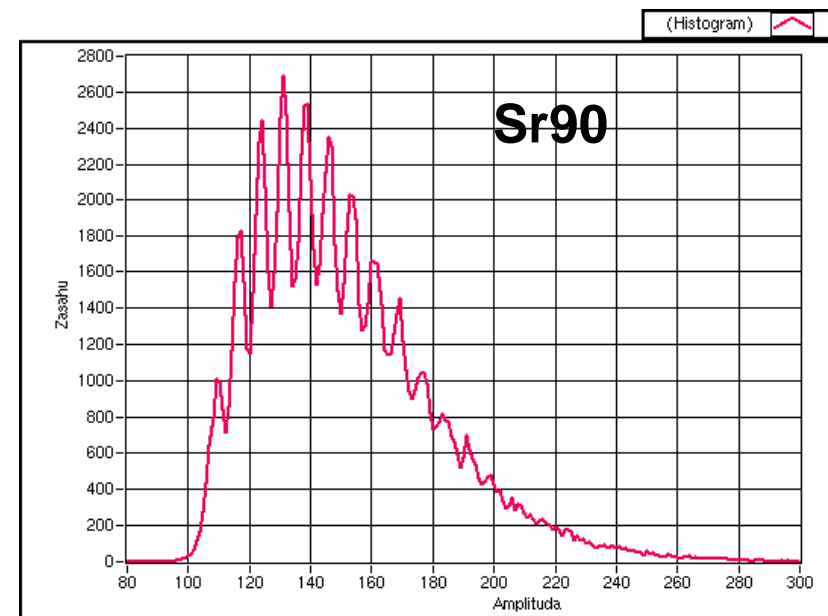
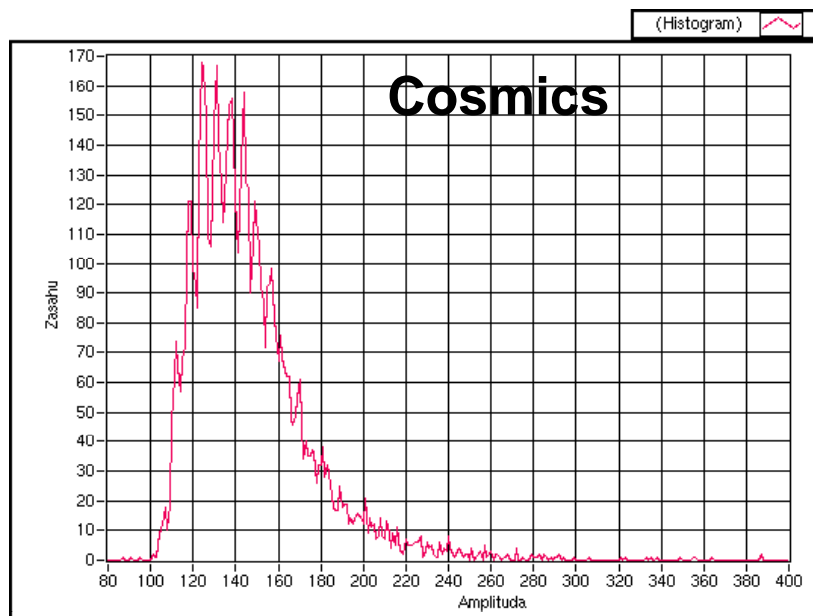
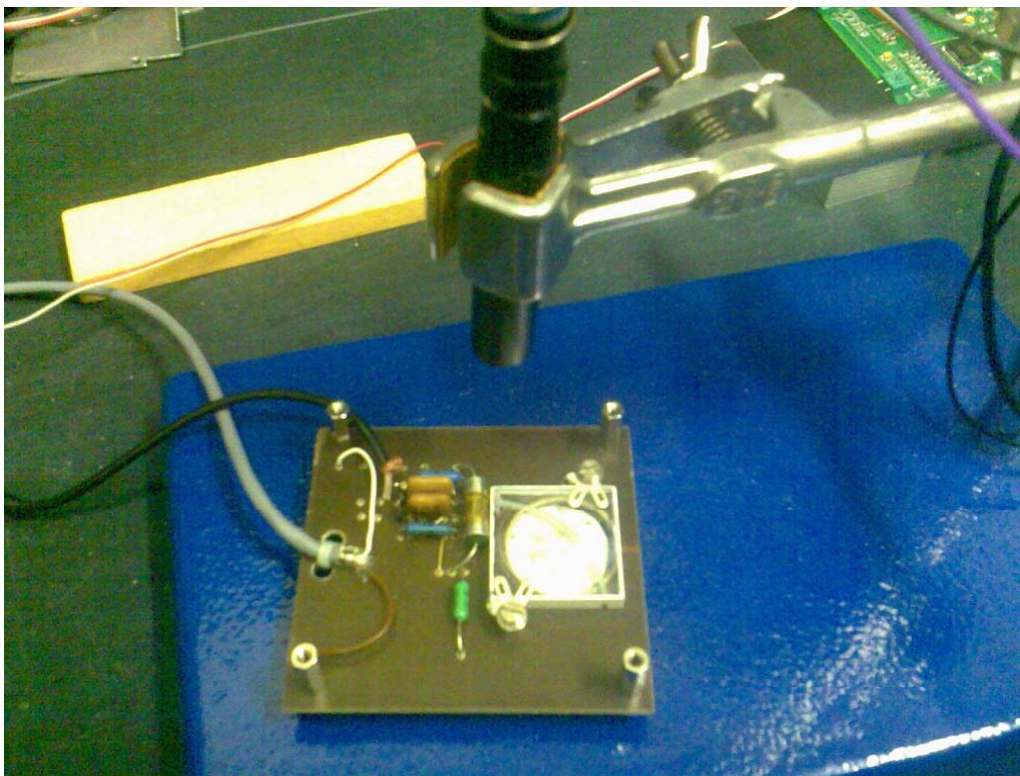
- Prototype of 5m long notched fiber delivered
- two groups of notches in the middle and tail
- one (~1mm long) cut per position of 6 or 12 cm int. (optical department of SAFIBRA company)

- QR LED driver, T- and V-calib
- UV LED
- fiber with notches
- scintillating tile 3x3cm w/ WLS fiber going to SiPM
- fiber fixed in middle of top plane
- PS for SiPM Ubias
- preamp (gain of 10)
- R/O scope and ADC (VME)
- LabView DAQ

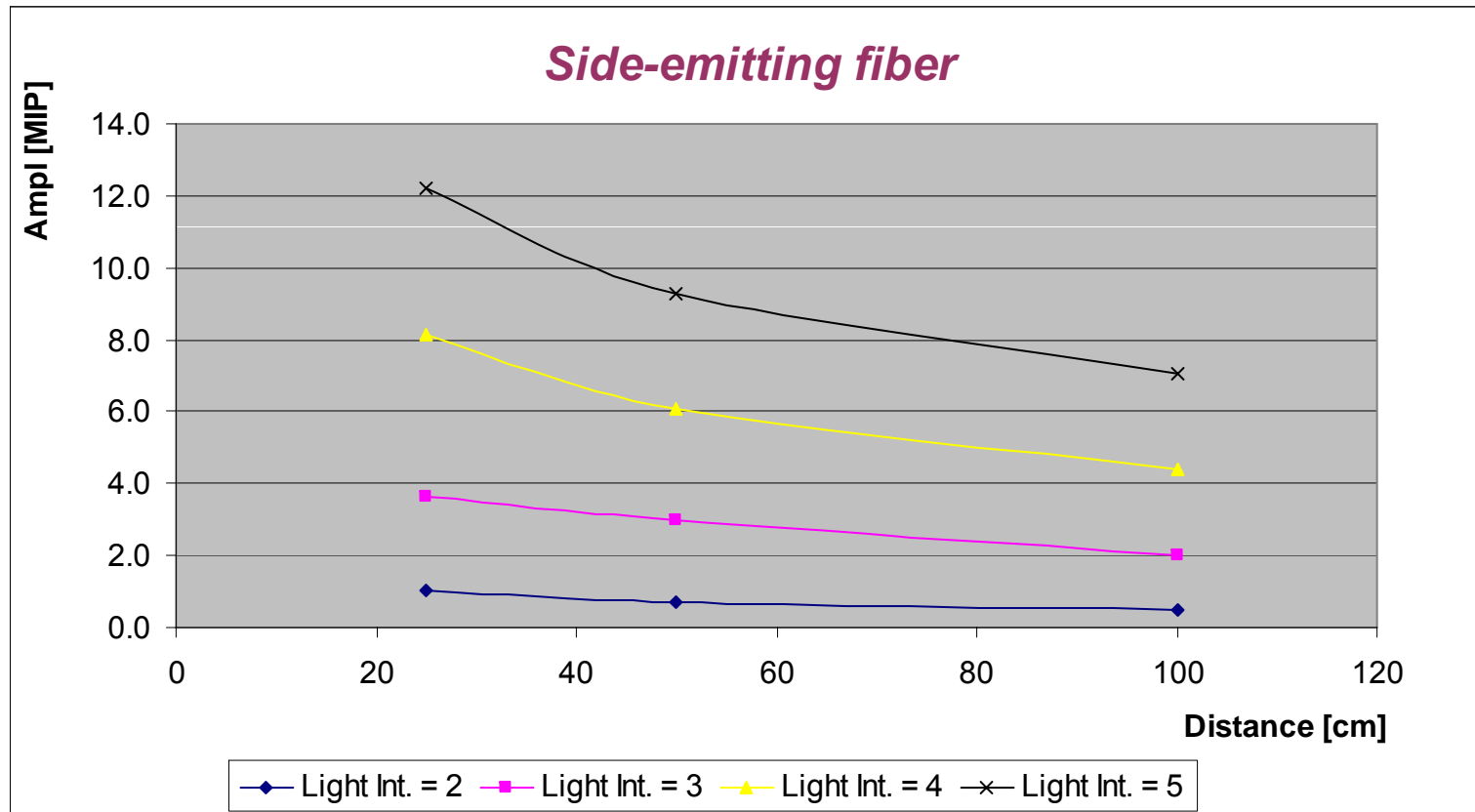


SiPM response to MIP

MIP from cosmics ~ 7 pixels
MIP from Sr90 ~ 8 pixels



Repeated measurement of side-emitting fiber with SiPM response in 3 different position side for four UV LED light intensities (5 = maximum LED light from driver)

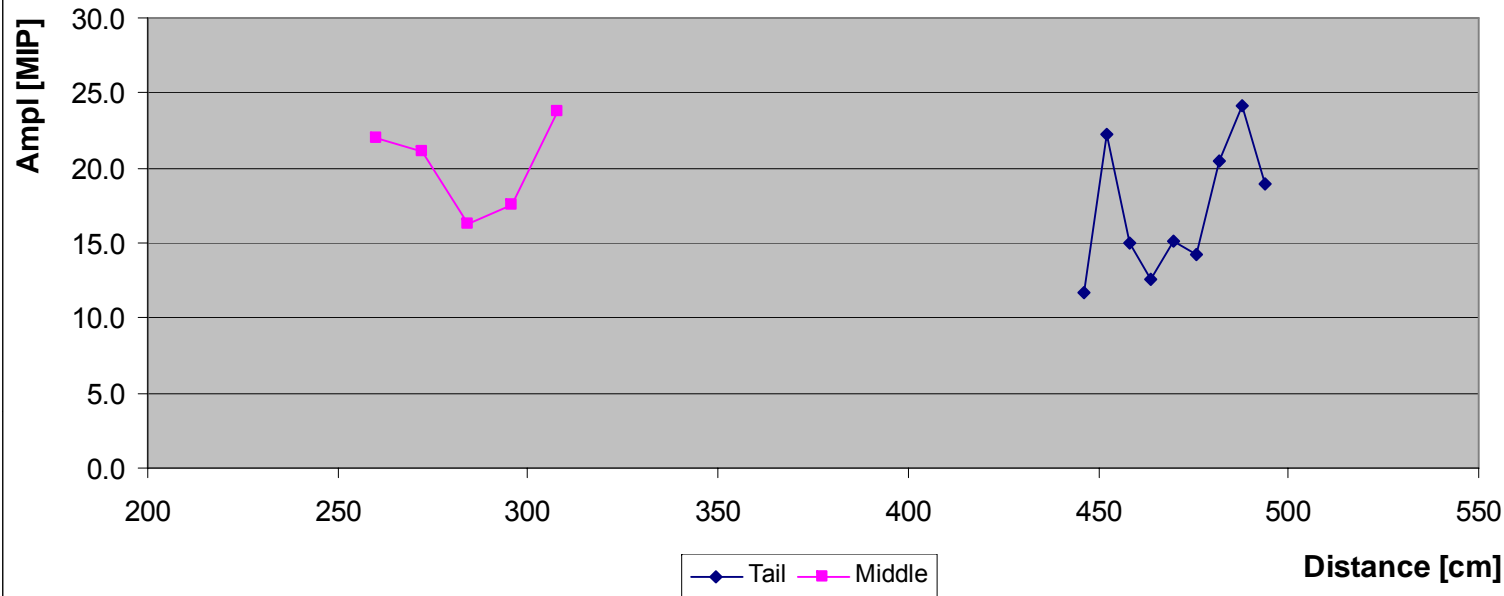


- 55% decrease of response in 75 cm
- within light intensities of more than 1 order

Results II

Amplitude measured in MIPs along the fiber

- 5 points every 12 cm
- 9 points every 6 cm (points = one 1mm cut)
- in average:
Tail 17.2 MIPs
Middle 18.6 MIPs

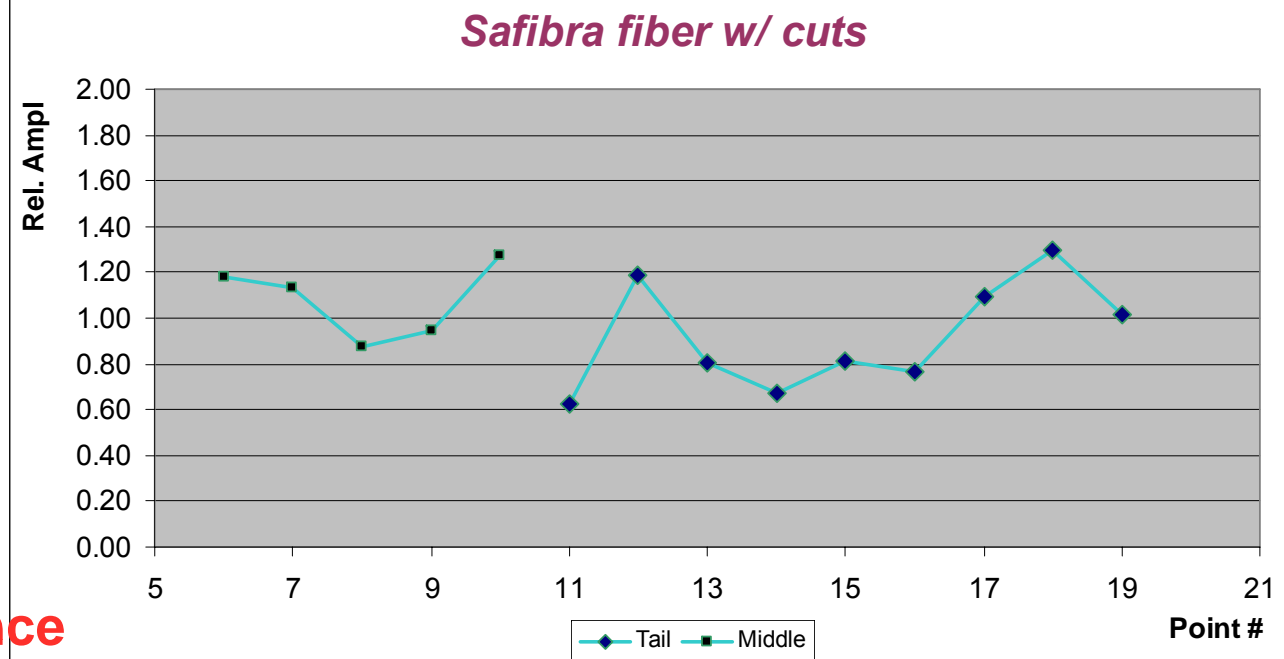


Normalized amplitude over 14 measured points divided to 2 groups acc. to position along fiber:

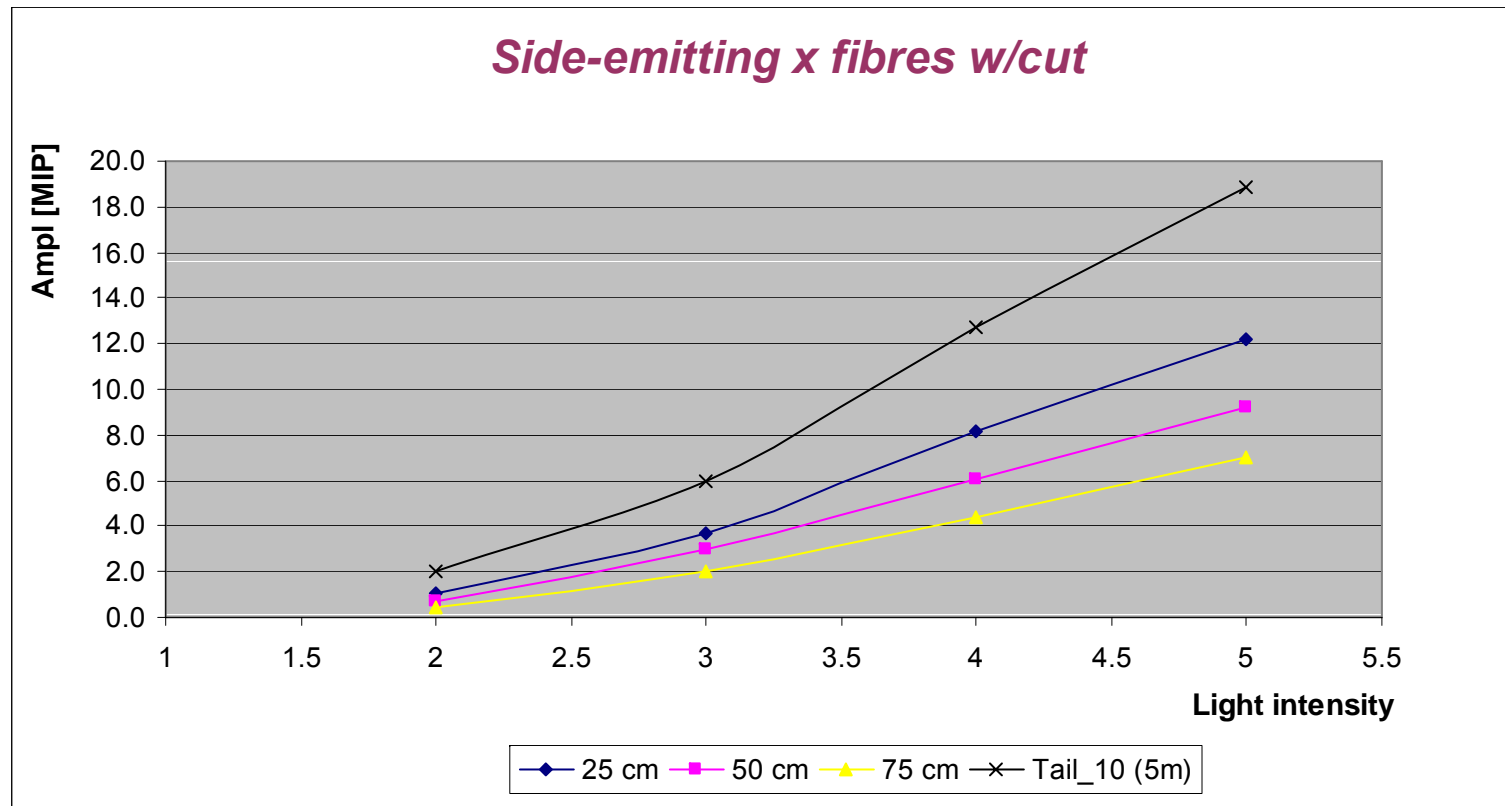
- middle part (~2.5m)
- tail part (~5m)

SiPM response on LED light

- varies -40 to 30 %
- RMS = 22%
- **does not depend on distance from light source**



- 3 position of side-emitting fiber
- 1 position (tail of 5m) notched fiber



- At highest light intensities the notched fiber shows much bigger SiPM response
- going from 55% to 170% with increasing distance from light source (up to 1m vs 5m)

Conclusion II

- ✓ First fiber prototype with test notches measured
- ✓ Response over 5m length varies with RMS of 22%
- ✓ Any visible change in uniformity
- ✓ Light output from notched fiber > 2.7times higher than from side-emitting fiber

- we need still more light intensity from fiber
 - i. bigger notches on fiber or multiplying them
 - ii. focusing enough LED light into one fiber

Both direction will be further investigated in June